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THE PATTERN OF DUNG FEEDING AND MAINTENANCE PRACTICES OF BIOGAS PLANTS IN THE CHHATTISGARH PLAINS, INDIA

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ABSTRCT

The operation and maintenance scope for a biogas system includes all work and inspections needed to ensure smooth functioning and longevity of service. There are general rules that apply to the entire biogas system and aim at enhancing and maintaining the functioning of the system. A field study was carried out during the year 2006 to 2008 on Biogas plants covering 11 districts of Chhattisgarh plains. The knowhow on biogas technology, maintenance practices and dung fed (%) were varying from districts to districts. The sample having floating drum type biogas plants and fixed DB type biogas were found to have dung water ratio between1:2 but there proportion varied from Floating Drum (FD) to Deen Bandhu (DB) Model. Adoption and non- adoption pattern in case of once in a day, once in two to three days and once in a week for FD and DB were tested by chi squire test.

KEYWORDS*: *Anaerobic Digestion, Biogas, Biomass, Chi- Square Test, Feeding Practices, Manure, Methane & Renewable Energy

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INTRODUCTION

Majority of the biogas plants in India are individual, household level plants. However, since only comparatively rich villagers have adequate number of cattle, marginal and small farmers, landless labourer and artisans in the villages were found to have rare biogas plants. The common needs of the villagers such as organic fertilizers in large quantities, lighting and water supply cannot be met from individual plants as privately owned individual biogas plants are used mostly for cooking and the sludge for fertilizing the fields. It is estimated that some 60 per cent of the world's population live in rural areas of developing countries and rely on agriculture for their livelihood. About one billion people rely on residue as their principal cooking fuel. In many areas, particularly in Asia, the commercialization of bio-residues is a source of modest income. At the same time it is a burden for poor people. Most often the utilization of bio-residue is associated with a very low efficiency and therefore, it has a high level of smoke emissions and a negative impact on health. Cattle dung is the main raw material used for biogas generation (Shailendra *et al*. 2016).

In Chhattisgarh, the Installation of biogas plants are carried out by the CREDA under the Department of Energy, Govt. of Chhattisgarh from 25th may 2001. Yearly, statistical data of Chhattisgarh state indicates that the biogas plants are getting popularity among the farmers of Chhattisgarh, which indicates the satisfactory performance

and level of technical knowhow of biogas plants in the region. Use of Biogas in Chhattisgarh is limited to only cooking purpose. It is a matter of interest to know the working status of biogas plants under different districts. If the plant does not perform satisfactory it should be treated as national loss. Because, huge number of biogas plants are installed annually, in the villages under the government subsidy program, by various agencies (Kumar Shailendra, 2008).

Establishment and proper functioning of community biogas plants are difficult, as changes in the amount of feeding and composition of feedstock can be responsible for process instabilities. Mass input is necessary for the biogas plant. Feed reduction can lead to a lower biogas production and feed increase can lead to acidification, and consequently to process instability. In addition to solid feed stocks, liquid feed stocks can affect the biogas output for two reasons. The first reason is that if they contain high amounts of organic matter. They will contribute to the daily feed of organic matter to the biogas plant. The second is that high amounts of liquids (e.g. rain water) in feedstock lowers the retention time and can lead to hydraulic overload. For a well-balanced biogas production, the stable biological process is necessary. Gas yields are directly related to the amount of biodegradable organic solids loaded into the digester. Organic matter content and the percentage of dry matter is an important factor for different digester systems.

Kumar S, *et al.*(2013) reported that the total population of biogas plants in the Chhattisgarh state is around 50,000 units. As the numbers of biogas plants installed by other than CREDA agencies are not exactly available; however, the floating types of plants are still seen in this area which is fabricated by KVIC. They further reported that by the year 2009-10, 30,376 number of biogas plants are installed by CREDA alone in ten years during 2001-10. Therefore, on an average more than three thousand (3375) plants are added annually, which indicate that the Biogas technology is getting popular in the Chhattisgarh state. As per farmer's perception, it has contributed in increasing agricultural production and saving to the forest wood.

Present Study and analysis were carried out to know the pattern of feeding practices and gap between recommended practices of the installed biogas plants in the selected districts of Chhattisgarh Plains.

MATERIAS AND METHODS

A field study was carried out with a questionnaire and by visiting 117 Biogas plants covering 11 districts of Chhattisgarh plains. Data collection tool (semi-structured questionnaire) was designed and tested before implementation to reflect a positive research approach, i.e enabling the biogas users to take a leading role in informing on the respective socio-economic variables being probed. To rationalize the study according to the study's focus, respondents were biogas consumers who had used it for more than three months and responses were separately solicited from female and male spouses/respondents in a household which attracts a strong rural focus Chhattisgarh state (CG) comprises with three agro-climatic zones namely Chhattisgarh plains, Baster platue and Northern hills of CG. Generally, the survey was focused on the issues of gap between prevailing feeding practices and recommended practices of biogas plants. An analysis was needed for further effective planning and implementation of the program. Therefore, in order to determine the answers of all such queries, present analysis was carried out at random field survey following a multi stage sampling technique.

Prevailing Plant Feeding Practices and Gap

Feeding practice of plant comprises the input of raw material in proper ratio, stirring of slurry, maintenance of temperature, pH and bacterial activities. The related information were collected from the respondent and by visiting their biogas plants and given below in Table 1.

Gap in Dung Feeding Practices

It was determined by weighing the input dung and by asking the farmers. The gap was determined in per cent of required dung. Primary data were collected from the owners through personal interview with the help of well-prepared schedule and questionnaire.

Dung- Water Ratio

It is one of the important parameters and affects gas generation. Dung-water ratio was measured with the help of volumetric flask and valance at site of plant.

Feeding in Morning

It is noted by asking respondents. By visiting the selected biogas plants, feeding time and time required for feeding is noted.

Stirring of Slurry

As per recommendation the digester should be stirred weekly by bamboo in DB model and rotating drum in FD model. It is noted by asking respondents.

Particle Size of Feeding Material

The particle size of digester feeding material affects the gas production. By visiting the biogas plants, particle size were noted among the owners by standard methods.

Maintaining Digester Temperature

Daily temperature was noted at the site of the plant with probe type temperature gage.

Maintaining of Digester pH

The pH of slurry measured with pH meter. The pH of slurry affects the production of biogas. For increase gas yield, a pH between 7.0 and 7.2 is optimum.

Addition of Wastes with Dung

Agricultural / feedstock may be added with dung to increase the quantity of feed material. By visiting and personal asking of the owners, addition of waste material with dung was noted.

Remove Water from Gas Pipe

It is noted frequencies of removal of water from gas pipe by asking the owners. The water vapors, when condense in the gas pipe, clog the gas pipe. The slope of gas pipe, sudden rise and fall of gas pipe temperature, which affect the condensation of vapors were noted at the site of the plant.

Cleaning of Burner

Corrosion of burner, dust particles, size of burner's openings, burner's clogging and color of flam were noted at the side of biogas plants.

Changing of Gas Pipes to Avoid Leakage

Leakage of pipe joints /connection's and cracking in wall and digester are checked and noted by smelling and with the help of shop- water solution.

Painting of Drums and Iron Pipes

To increase the durability of drum or to prevent the corrosion of drum and other appliances, it is recommended by the manufacturing agency that every year the drum should be removed from digester and painting is done after cleaning and checking of cracks. It is noted by asking to the plant owners.

Cleaning of Digester

Cleaning of digester is recommended in every five years. It is noted by asking to the plant owners.

RESULTS AND DISCUSSIONS

Gap in Dung Feeding and Maintenance Practices in Biogas Plants

The feedbacks collected from farmers are presented in Table 1. It was observed that the most plants are not fed with the desired quantity of dung. In the surveyed biogas plants which were conducted covering 117 respondents from each district of Chhattisgarh Plains, the prevalent practices were observed and gap in recommending and prevalent practices was determined and presented in Table 1.

Gap in Dung Feeding Rate

It was observed that the dung-feeding rate varied with farmer to farmer. However, in general the plants are fed in the range of 55 to 102 % of the required quantity and average feeding rate was found 71.3 % of the required quantity. On an average the dung is fed at the rate of 18 kg / m^3 (Table 1).

Dung-Water Ratio

It is one of the important parameters and affects gas generation. As shown in Table 1 the recommended ratio is 1:1-1.5 depending upon dung quality and season.

It was reported by 70 % of the total respondents, which were having floating-dome type biogas; follow more dung–water ratio (1:2), than the fixed DB type plants (1:1-1.25). The Table indicated that in case of fixed dome model, about 30 % of owner follows a ratio of 1:1 and about 40 % follow 1:1.25 and about 30 % follow 1:2. It revealed that recommended practice for mixing of dung–water (1-1-1.5) is followed by 70 % respondent.

Feeding in Morning

It is being followed as reported by the respondents (Table 1). Mostly female workers do feeding in the morning during the summer and afternoon during winter seasons. During winter it was delayed to heat the input dung water mixture and to maintain the slurry and digester temperature with hot water. Water is collected in buckets and kept in open, to increase its temperature through direct solar energy. Thus, when this hot water is mix with dung, it increases the slurry temperature.

Table 1: Prevalent Dung Feeding and Maintenance Practices of Biogas Plants in the Chhattisgarh Plains

S. N.	Parameters	Recommended Practices	Prevailing Practices	Practice Being Followed	
				In Floating Drum	In Deenbandhu
1	Dung fed,kg/m^3 /day, **Average**	25-30 kg / m^3	18 kg/ m^3	14.2kg/m^3	21.5 kg/m^3
2.	Dung water Ratio	1:1-1.25	1:1	10 %	30%
			1:1.25	20 %	40%
			1:2	70 %	30%
3.	i). Feeding in Morning	As per day feed temp. Worm water desirable (30-35 ^{0}C)	Followed by 80%	With available water	With available water
	ii). Feeding after noon		By 20%	With available water	With available water
4.	Stirring of Slurry	Once in a day in FD and weekly in DB	Once a day	16 %	20%
			In 2-3 day	16 %	40%
			In a weak	68 %	40%
5.	Size of particle	Straw can be added, Finer desirable	Only dung added	Only dung added	Only dung added
6.	Maintaining digester temperature (30-37^0 C)	Covering by paddy stalk / adding hot water	Negligibly followed	2 Respondents follow.	Not followed
7.	Maintaining of digester pH	Urea or animal urine can be added	Not followed	Nil	Nil
8.	Addition of Wastes with dung	Agricultural / feed stock waste can be added	Not followed	Nil	Nil
10.	Adding of metal particles to accelerate the gas generation	Nickel *etc.*	Not followed	Nil	Nil
11.	Remove water vapors from hose pipe	Weekly by Drain plug	Weekly by 10 % Monthly by 30 %	Weekly by 10 % Monthly by 30 %	Weekly by 10 % Monthly by 30 %
12	Cleaning of burner	Weekly with wire by removing burner	Weekly by 5 % Monthly by 95 %	Weekly by 5 % Monthly by 95 %	Weekly by 5 % Monthly by 95 %
13	2-3 pits made for collecting slurry.	For drying and quick dispose off	Only one slurry pit found	Drying by spreading as & when required.	Drying by spreading as & when required
14	Changing of gas pipes to avoid leakage	Change pipes annually	Problems removed, when gas smell	Due to cracking of old pipe (40%)	By loose joints (20 %), By outlet (40 %)
15	Painting of drum and Iron pipes	Coating with red oxides per year	Inner/outer painting done by *Epansi* paint.	Yearly (90 %)	Not followed.
16	Cleaning of digester	In five year interval	5 Year	In 5 yr (50 %)	In 5 yr (50 %)
			10 Year	Followed by 100 %	Followed by 100 %

Stirring of Slurry

The steering of slurry improves the gas production. About 15.8% additional gas was produced with stirred slurry than non-stirred slurry (Ojha, 2006). As per recommendation the digester should be stirred weekly and it was found that this practice is being followed more frequently at 1-3 days interval by 60 % owners and once in a week by 40 % owners, in case of D B type plant. However, it was found that there was too much gap in stirring practice in case of FD drum. It was found that only 16 % owner follow the practice of daily stirring in case of FD.

The pattern of adoption and non adoption of stirring in slurry in biogas plants carrying FD and DB in cases of once a day, 2 -3 days and once in a week was tested by 2X2 contingency table of χ^2 test where chi squire tabulated (1) at 5% = 3.841.

In case of once in a day adaptation and non- adaptation pattern for FD and DB biogas plants, the chi squire calculated (1) at 5% = 0.542. Similarly, in case of once in 2- 3 days, adaptation and non- adaptation pattern for FD and DB biogas plants, the chi squire calculated (1) at 5% = 14.28. Again, in case of once in a week, adaptation and non- adaptation pattern for FD and DB biogas plants of stirring in slurry, the chi squire calculated (1) at 5% = 15.78.

Thus adoption and non- adoption of stirring of slurry in case of once in day has no association with FD and DB biogas plants But adoption and non adoption pattern of stirring of slurry in case of once in two to three days and once in a week is significantly associated.

Particle Size of Feeding Material

The particle size of digester feeding material affects the gas production. Biogas generation is increased when the feeding organic material is smaller than 1mm (Sharma *et al*, 1988 and *Ojha*, 2oo6). Because, the increased surface area does help in increasing the microbial activity. However, as shown in table, no practices were found among the owners because they fed only dung and no feedstock or crop wastes are added into the plant.

Maintaining Digester Temperature

It is well known fact that the production of biogas depends up on the anaerobic digestion of the biomass, which is affected by the temperature. The best range of temperature for growing methanogenic bacteria is reported to be 33-40 ^{0}C (Rai, 1997). The Table 1 reveals that the practice for maintaining digester temperature was found negligible in Chhattisgarh Plains. In this zone the winter condition sets in mid November when the average minimum temperature starts falling below 15 ^{0}C. The northern districts especially Bilaspur division have more severe and long winter period than southern part of C.G., especially in Bastar division. In Chhattisgarh, May is the warmest month and maximum temperature in this month increased upto 46 ^{0}C in Raipur and Raigarh districts (Choudhary, 2001).

Maintaining of Digester pH

pH of the slurry affects the production of biogas. For increase gas yield, a pH between 7.0 and 7.2 is optimum, though the gas production is satisfactory between pH 6.6-7.6. (Chawla, 1986). No respondent reported for adoption of the practice (Table 1). Among the respondents, no practice was reported to be followed to maintain the pH of slurry.

Addition of Wastes with Dung

Agricultural / feedstock may be added with dung to increase the quantity of feed material. There were not found addition of wastes with dung among the farmers.

Adding of Metal Particles to Accelerate the Gas Generation

Adding of metal particles is done to accelerate the gas generation (Geeta *et al*, 1990) However, in the survey, among owners, no practices was found to be reported (Table 1).

Removal of Water from Gas Pipe

The respondents /owners reported it that the water vapor, when condensed in the gas pipe clogged the gas pipe. As shown in the Table 1, it was noted that only 10 % owners remove water from the gas pipe weekly with the help of water plug. It was also noted that this problem occurred when the slope of pipe was not proper. Giving slag bend in the pipe to collect the condensed water vapor as the vapor condensed and clogs the gas pipe. It was recommended that at the every lower position of gas pipe, a water plug must be provided to remove water from the gas pipe.

Cleaning of Burner

It was found on the survey (Table 1) that corrosion of burner and deposition of dust particles often clogged the openings of burner. It reduced burner efficiency and change color of flame from blue to red. The bottom of pods was blocked. As per recommended practice the burner's openings need to be cleaned weekly. However, only 5% owner followed the recommended practice and 95 % owners reported that they cleaned the burner monthly or when problems encounter.

Disposal of Slurry

It is recommended by CREDA that when first pit is full with slurry, the flow of slurry is diverted to other pit. So that dry handy slurry can be achieved. But it was found by survey that owners have only one pit to collect the slurry.

Changing of Gas Pipes

Changing of gas pipes annually is recommended to avoid gas leakage. Leakage of gas at pipe connection's / joints and at the cracks are checked regularly, by feeling smell and with the help of soap’s water. The farmer/owners change the gas pipe when problem occur only. They reported that leakage checked by dipping pipes into soap water. Leakage in pipe due to cracking was found to be 40 % and at loose joints 20 % (Table 1).

Painting of Drum and Iron Pipes

To increase the durability of drum and pipes and to prevent the corrosion, the as per the recommendation of the manufacture ring agency the drum should be removed every year from digester and after cleaning and through checking it should be painted. It is reported by owners that 90 % owners paint their drum every year (Table 1).

Cleaning of Digester

Cleanings of digester is recommended in every five year. However, the result of survey revealed that only 50 % owners of the respondents have followed the recommendation. It is recommended by manufacturing agency that after 5 years, the whole slurry should be removed from the digester and inner and outer surfaces of the plants are cleaned and

painted.

CONCLUSIONS

In ideal and proper feeding conditions, theoretically, the larger size plants are found more economical than the smaller as the hourly operating cost reduces from Rs. 2.26-1.8 with increase in size of plant. The knowhow on biogas technology, maintenance practices and dung fed (%) were found more in district Mahasamund than other districts which influenced gas generation efficiency, therefore biogas generation efficiency was found maximum in district Mahasamund (83.5 %) and lowest in Rajnandgaon (71.6 %).

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